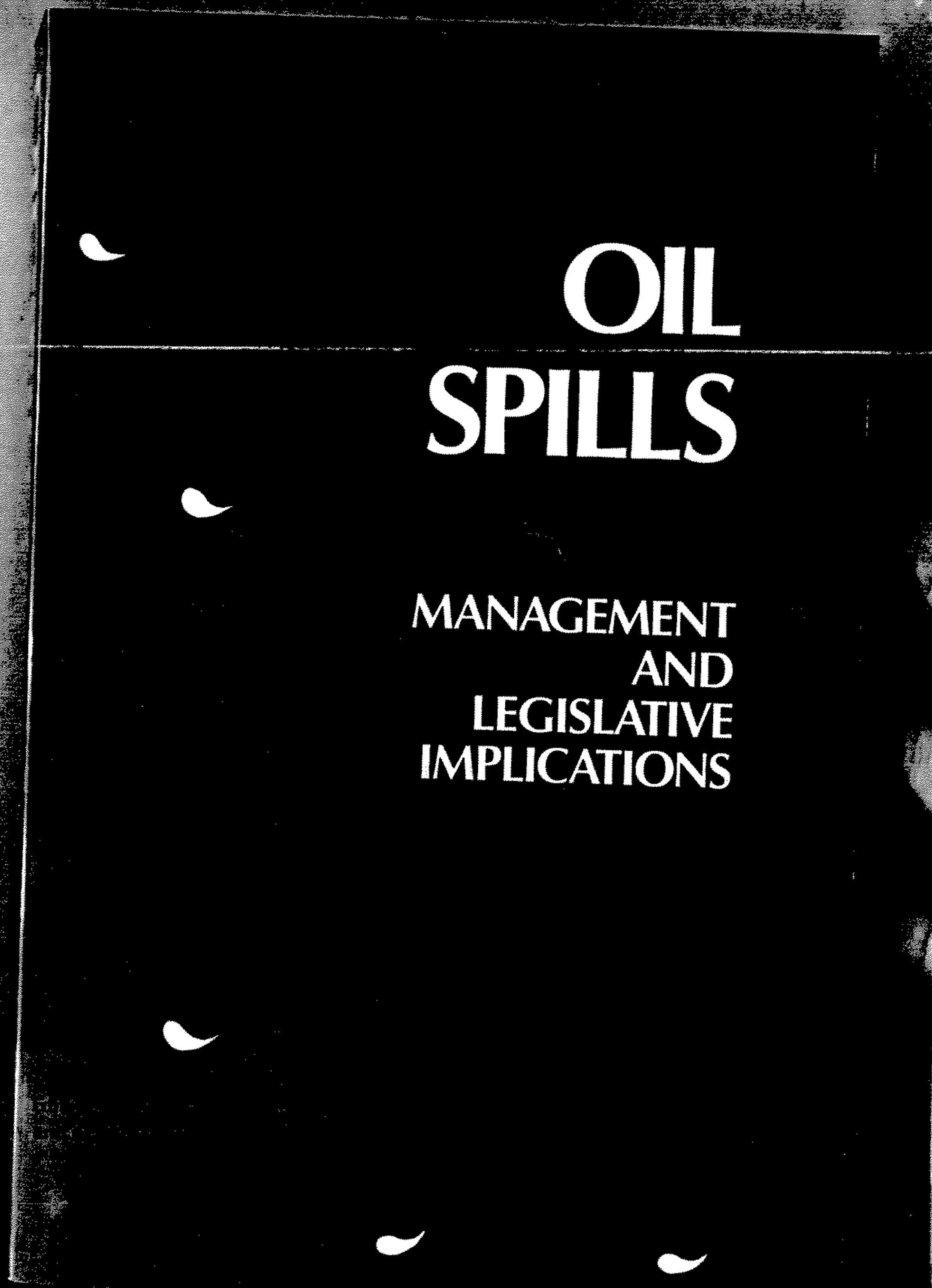
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LEGISLATIVE
IMPLICATIONS

effectiveness, and in situ burning, and to incorporate these data into the contingency planning process.

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RECENT RESULTS FROM OIL-SPILL RESPONSE RESEARCH

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Abstract

Recent large oil spills from tankers have reaffirmed the need for continuing technology assessment and research to improve oil-spill response capabilities. The Minerals Management Service (MMS) remains a lead agency in conducting these studies. This paper discusses MMS concerns, as reinforced by the acceleration of its research program in 1990. It briefly describes assessment of the current state-of-the-art technology for major aspects of spill response, including remote sensing, open-ocean containment, recovery, in-situ burning, chemical treating agents, beachline cleanup, and oil behavior.

The paper emphasizes the results of specific research projects that have begun to yield information that will improve detection and at-sea equipment performance. The first detection project, for which MMS has patent pending, involves the use of shipboard navigational radar to track slicks at relatively long range. The second project involves the use of conventional containment and cleanup in a downwind mode, which is contrary to the traditional procedures.

The paper also stresses current research projects, including the development of an airborne, laser-assisted fluorosensor, which determines whether apparent slicks contain oil. Additional projects involve the development of improved strategies for responding to oil in broken-ice conditions, for gaining an improved understanding of the fate and behavior of spilled oil as it affects response strategies, and for reopening and operating the Oil and Hazardous Materials Simulated Environmental Test Tank (OHMSETT) facility in Leonardo, New Jersey. Recent progress on the development of safe and environmentally acceptable strategies to burn spilled oil in-situ is also discussed. The OHMSETT facility is necessary for testing prospective improvements in chemical treating agents and

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to develop standard procedures for testing and evaluating response equipment.

Introduction

A number of factors have to be considered in the evaluation of the adequacy of spill response. These include sea-state and weather conditions, type of oil, size of spill, elapsed time from spill to response, presence of ice, and level of response effectiveness. Readiness includes the siting of sufficient equipment and trained personnel to address spill response issues. A major aspect of preparedness is the state-of-the-art technology of existing equipment and procedures, including capabilities for detection, containment, recovery, disposal, alter- native responses, e.g., chemical treating agents and in-situ burning.

Detection

Practical oil-spill detection is still done by visual observation, which is limited to favorable sea and atmospheric conditions and is not possible in rain, fog, or darkness. Airborne remote sensing packages have been developed using side-looking radar, infrared and ultraviolet/false color cameras. These systems are not resources usually available to responders.

The Minerals Management Service (MMS) research, (Tennyson, 1988) has produced a method of specially tuning shipboard navigational radar to track oil spills under all, except extremely rough,sea conditions. This technique has been used successfully on three successive oil spills.

This detection technique has been successful in locating spills as small as five barrels out to a distance of 12 nautical miles. It depends upon harmonic resonance of X-band radar as a result of back scattering from short (approximately 5 cm) wavelength wave trains. These waves occur at sea in wind velocities from approximately 3 knots up to hurricane force winds. In repeated trials offshore Nova Scotia in 1987, the presence of significant breaking seas coupled with large swells (above 1.5 meters) obscured the slick. It is unclear whether this was a wave-induced phenomenon or whether the small slicks were rapidly dissipated and no longer detectable. Fog and rain had no effect on detection. There is an apparent correlation between slick thickness and the radar image. As the slicks

dispersed to sheen thickness, the radar imagery became less distinct.

Before the radar technique can become a reliable operational tool, additional research is necessary to correlate slick characteristics, e.g. slick thickness and sea conditions with the radar presentation. The completion of an MMS/Esso Research Ltd., Canada, and Environment Canada (EC) research effort to design and evaluate an airborne laser thickness sensor for oil slicks will help provide additional information.

The airborne laser thickness sensor for oil slicks has been thoroughly evaluated in the laboratory and a system potentially can be made flyable within the next 2 years. Presently, airborne remote sensing packages cannot discriminate between areas of a slick which are thick enough to recover and portions too thin for reasonable response effort. Observations indicate that slicks do not dissipate uniformly at sea. The majority of the oil remains in small areas of concentration compared to the total area of the slick. Future studies will address the airborne sensors capability to rapidly transmit the location and configurations of the thicker portions of the slick to the responder in real time.

Existing remote sensing packages routinely indicate false slicks as potential oil slicks. This may be overcome when weather conditions are good allowing the joint use of side-looking-airborne-radar (SLAR) and ultraviolet and infrared sensors. Visual confirmation of oil remains the most certain detection technique. Still fresh oil, freshwater inflows, seaweed, tidal riplines, debris etc., can be mistaken for oil slicks.

The EC began a research project which MMS joined in 1987, to develop a system that could be transported in small twin engine aircraft, and could discriminate between spurious targets and those containing oil. It has been proven in the laboratory that the airborne laser fluorosensor can distinguish between biogenic and petrogenic oil. This system also appears to have potential for identifying oil on shorelines and in broken ice conditions. This technique uses lasers and should offer a significant increase in detection capabilities. The MMS anticipates that an experimental system will be flyable within the next 18 months.

Containment

Capabilities for using open ocean booms to contain oil are unquantified in waves over 2 to 3 feet. Yet these wave heights are often exceeded on the Outer Continental Shelf (OCS). Conventional knowledge indicates that containment booms will not effectively operate in wind speeds over 15 to 20 knots or at tow speeds exceeding 1/2 to 3/4 knots. During MMS/EC experimental oil-spill operations conducted off the coast of St. John's, Newfoundland, oil was successfully contained by booms towed with the wind, instead of against it, in contravention of conventional practice. This new technique resulted in successful slick containment in winds up to 35 knots and at tow speeds up to 1.4 knots (Tennyson and Whittaker 1988).

Currently, there are more than 30 different boom designs in use in the OCS. The relative capabilities of these booms have not been properly quantified for lack of a standardized testing technique or protocol. The MMS, the EC, the U.S. Coast Guard, (USCG) and the Environmental Protection Agency have initiated the development of an extensive test protocol in 1985 that would rate the performance of containment booms without requiring the intentional spillage of tens of thousands of gallons of oil as is the current international practice. This protocol was evaluated and verified off the coast of Newfoundland in 1987 (Nash and Hillger, 1988). Standard nonpolluting test procedures are being devised to evaluate the performance of each containment boom in a wide range of sea states.

Recovery

Several offshore skimmers of differing oil retrieval concepts have been evaluated at OHMSETT and elsewhere in realistic offshore conditions. Additional testing of conventional systems would be of minimal value. However, MMS, EC, (USCG), and the American Petroleum Industry (API) are jointly searching for innovative skimmers for evaluation. One such skimmer, based upon a Finnish prototype, appears to have significant potential for oil recovery in a wide range of broken ice conditions. This device makes use of proven ice-handling techniques, efficiently contacting the oil slick with minimal ice movement. Negotiations on testing this skimmer are continuing.

Chemical Treating Agents

Chemical treating agents involve 11 major categories of treating agents including sorbents, solidifiers, or gelling agents, sinking agents, surface washing agents, dispersants, biodegradation agents, biodegradation enhancers, de-emulsifiers, burning agents, and herding

agents. The MMS and EC began in 1987 to develop a better understanding of the mechanism of dispersant action. This task was undertaken because of the controversy over the field effectiveness of dispersants and because laboratory effectiveness measurement protocols did not yield reproducible data. Laboratory tests were normalized using more realistic oil to water ratios and allowing a settling time prior to the effectiveness evaluations. This new test yielded reproducible (within 5%) results and was used to evaluate a range of crude oils and products with commercially available and experimental dispersants (Fingas, et al., 1990). Table 1 shows the results of this research.

TABLE 1

DISPERSANT EFFECTIVENESS		EFFECTIVENESS PERCENT			
OIL	DISPERSANT	AVERAGE	% PREMIXED	% 1 DROP	% 2 DROPS
ADGO	C 9527	61	61	82	41
ADGO	CRX-8	39	61	31	26
ADGO	ENER 700	59	76	53	47
ADGO	DASIC	8	11	7	5
AMAULIGAK	C9527	45	50	36	49
AMAULIGAK	CRX-8	50	61	51	37
AMAULIGAK	ENER 700	62	65	62	59
AMAULIGAK	DASIC	28	23	40	22
AMAULIGAK	DREW	0	TL	TL	TL
AMAULIGAK	C 9550	0	TL	TL	TL
AMAULIGAK	BQ	60	72	52	57
AMAULIGAK	II	0	22	TL	TL
ARABIAN LIGHT	C 9527	17	31	16	3.3
ARABIAN LIGHT	CRX-8	9	15	8.6	4.8
ARABIAN LIGHT	ENER 700	22	16	27	23
ARABIAN LIGHT	DASIC	33	24	36	40
ARABIAN LIGHT	BQ	42	28	54	43
ASMB	C 9527	33	42	28	28
ASMB	CRX-8	45	57	43	35
ASMB	ENER 700	51	68	51	35
ASMB	DASIC	24	18	27	28
ASMB	DREWLT	0	TL	TL	TL
ASMB	C 9550	0	TL	TL	TL
ASMB	BQ	79	81	82	73
ASMB	II	18	49	5	0
ASMB	WELLAID 3315	14	8	12	21
ASMB	BPI100WD	12	6	14	17
ASMB	BPI100X	7	1	10	11
ATKINSON	C 9527	39	59	31	27
ATKINSON	CRX-8	31	67	19	7
ATKINSON	ENER 700	73	79	75	66
ATKINSON	DASIC	49	33	61	53
AVALON J-34	C 9527	11	18	7.5	8
AVALON J-34	CRX-8	5	7.6	5.3	3.3
AVALON J-34	ENER 700	11	15	12	7
AVALON J-34	DASIC	16	8	18	21
AVALON J-34	BQ	10	11	11	7.1
AVALON ZONE 4	C 9527	10	14	10	5.7
AVALON ZONE 4	CRX-8	7	14	4.2	3.1
AVALON ZONE 4	ENER 700	26	25	27	27
AVALON ZONE 4	DASIC	30	12	40	38
AVALON ZONE 4	BQ	13	16	14	10

OIL	DISPERSANT	AVERAGE	% PREMIXED	% 1 DROP	% 2 DROPS
BENT HORN	C 9527	17	12	17	21
	DISPERSANT EFFECTIVENESS		EFFECTIVENESS PERCENT		
BENT HORN	CRX-8	20	BENT HORN		
ENER 700 23 10	18	42			
BENT HORN	DASIC	35	14	43	48
BUNKER C	C 9527	1	2.3	1.1	1
BUNKER C	CRX-8	2	3.8	1.3	0.9
BUNKER C	ENER 700	1	0.9	1.9	0.8
BUNKER C	DASIC	2	2.1	2.9	0.5
BUNKER C	BQ	1	1.4	1.4	0.8
BUNKER C LIGHT	C 9527	1	0.6	1	0.4
BUNKER C LIGHT	CRX-8	1	0.7	0.9	0.7
BUNKER C LIGHT	ENER 700	1	0.7	2	1.5
BUNKER C LIGHT	DASIC	1	0.6	1.7	1.3
BUNKER C LIGHT	BQ	2	1.6	2.6	0.8
CALIFORNIA CRUDE (11.0)	C 9527	1	0.5	1.1	0.9
CALIFORNIA CRUDE (11.0)	CRX-8	1	2.3	1.2	0.8
CALIFORNIA CRUDE (11.0)	ENER 700	1	1.4	2.7	0.8
CALIFORNIA CRUDE (11.0)	DASIC	1	0.2	2.2	0.8
CALIFORNIA CRUDE (11.0)	BQ	1	0.4	2.2	1.7
CALIFORNIA CRUDE (15)	C 9527	1	1.3	0.7	0.3
CALIFORNIA CRUDE (15)	CRX-8	1	0.4	0.8	0.6
CALIFORNIA CRUDE (15)	ENER 700	1	0.9	0.9	1
CALIFORNIA CRUDE (15)	DASIC	2	0.8	3	3.1
CALIFORNIA CRUDE (15)	BQ	1	1.4	1.3	0.8
COHASSET	C 9527	95	88	100	98
COHASSET (11.2%)	C 9527	96	88	99	100
COHASSET (25.6%)	C 9527	88	75	92	97
COHASSET (28.1%)	C 9527	90	74	97	100
COLD LAKE BITUMEN	C 9527	2	1.9	2.3	0.4
COLD LAKE BITUMEN	CRX-8	1	1.1	2.1	0.6
COLD LAKE BITUMEN	ENER 700	1	0.9	1.4	0.4
COLD LAKE BITUMEN	DASIC	1	1	1	0.3
COLD LAKE BITUMEN	BQ	1	1.1	1.5	0.3
ENDICOTT	C 9527	7	17	2.3	2.8
ENDICOTT	CRX-8	8	20	1.3	2.6
ENDICOTT	ENER 700	6	10	2.4	6.4
ENDICOTT	DASIC	14	8.1	15	18
ENDICOTT	BQ	13	18	6.9	13
ENDICOTT (7.5% W.)	C 9527	3	3	3	3
ENDICOTT (7.5% W.)	CRX-8	4	5	3	3
ENDICOTT (7.5% W.)	ENER 700	6	4	6	9
ENDICOTT (7.5% W.)	DASIC	4	1	1	11
ENDICOTT (7.5% W.)	BQ	6	4	6	7
ENDICOTT (11.7% W.)	C 9527	2	2	2	2
ENDICOTT (11.7% W.)	CRX-8	2	2	3	2
ENDICOTT (11.7% W.)	ENER 700	6	2	9	6
ENDICOTT (11.7% W.)	DASIC	3	1	3	4
ENDICOTT (11.7% W.)	BQ	4	1	6	6
FEDERATED	C 9527	25	41	24	11

OIL	DISPERSANT	AVERAGE	%PREMIXED	% 1 DROP	% DROPS
FEDERATED	CRX-8	31	50	26	16
	DISPERSANT EFFECTIVENESS		EFFECTIVENESS PERCENT		
FEDERATED	ENER 700	40	41	56	22
FEDERATED	DASIC	38	23	55	35
FEDERATED	BQ	64	66	85	42
HIBERNIA	C 9527	6	13	1.9	1.8
HIBERNIA	CRX-8	6	14	2.6	2
HIBERNIA	ENER 700	10	7.3	10	14
HIBERNIA	DASIC	14	8.6	18	16
HIBERNIA	BQ	9	7.8	12	6
HIBERNIA	WELLAID 3315	4	3	4	4
HIBERNIA (15.4%)	C 9527	4	6.1	2.3	2.5
HIBERNIA (15.4%)	CRX-8	3	5.8	1	2
HIBERNIA (15.4%)	ENER 700	8	5	11	7.5
HIBERNIA (15.4%)	DASIC	7	1	8	11
HIBERNIA (15.4%)	BQ	5	4	6	4
ISSUNGAK	C 9527	66	70	93	35
ISSUNGAK	CRX-8	60	58	75	47
ISSUNGAK	ENER 700	62	51	79	57
ISSUNGAK	DASIC	51	31	60	61
ISSUNGAK	BQ	77	77	69	84
LAGO MEDIO	C 9527	5	9.5	3.6	1.5
LAGO MEDIO	CRX-8	5	13	1.8	1.4
LAGO MEDIO	ENER 700	13	11	21	5.9
LAGO MEDIO	DASIC	15	4.1	18	24
LAGO MEDIO	BQ	18	22	25	6.3
MOUSSE MIX	C 9527	6	9	5	3
MOUSSE MIX	CRX-8	9	15	8	5
MOUSSE MIX	ENER 700	14	10	19	13
MOUSSE MIX	DASIC	17	9	22	20
MOUSSE MIX	BQ	18	25	17	12
MOUSSE MIX	II	6	15	3	0
NORMAN WELLS	C 9527	36	51	40	17
NORMAN WELLS	CRX-8	43	60	38	30
NORMAN WELLS	ENER 700	51	73	26	53
NORMAN WELLS	DASIC	26	19	33	27
NORMAN WELLS	DREWLT	0	TL	TL	TL
NORMAN WELLS	C 9550	0	TL	TL	TL
NORMAN WELLS	BQ	77	83	80	68
NORMAN WELLS	II	0	33	TL	TL
PANUK	C 9527	96	95	95	97
PANUK	CRX-8	78	100	62	71
PANUK	ENER 700	96	93	97	99
PANUK	DASIC	40	44	38	37
PANUK	BQ	100	100	100	99
PANUK (47.4% W.)	C 9527	99	96	100	100
PANUK (53.2% W.)	C 9527	99	96	100	100
PRUDHOE BAY	C 9527	13	19	13	7
PRUDHOE BAY	CRX-8	13	23	9	6
PRUDHOE BAY	BQ	32	43	29	24
PRUDHOE BAY	ENER 700	35	48	26	31

DISPERSANT EFFECTIVENESS		EFFECTIVENESS PERCENT			
OIL	DISPERSANT	AVERAGE	% PREMIXED	% 1 DROP	% 2 DROP
PRUDHOE BAY	DASIC	11	14		18
PRUDHOE BAY (1989)	C 9527	7	13	5.8	2.5
PRUDHOE BAY (1989)	CRX-8	7	15	3.2	3.9
PRUDHOE BAY (1898)	ENER 700	10	15	3.1	13
PRUDHOE BAY (1989)	DASIC	14	11	18	13
PRUDHOE BAY (1989)	BQ	15	25	4.8	16
PRUDHOE BAY (1989)	WELLAID 3315	4	3	5	3
PRUDHOE BAY (89) (7.6% W)	C 9527	6	9	3	5
PRUDHOE BAY (89) (7.6% W)	CRX-8	6	13	3	3
PRUDHOE BAY (89) (7.6% W)	ENER 700	16	8	25	16
PRUDHOE BAY (89) (7.6% W)	DASIC	16	12	19	18
PRUDHOE BAY (89) (7.6% W)	BQ	19	29	18	10
PRUDHOE BAY (89) (14.5% W)	C 9527	4	5	4	3
PRUDHOE BAY (89) (14.5% W)	CRX-8	4	8	2	3
PRUDHOE BAY (89) (14.5% W)	ENER 700	8	4	6	14
PRUDHOE BAY (89) (14.5% W)	DASIC	10	2	14	13
PRUDHOE BAY (89) (14.5% W)	BQ	9	7	15	5
SOUTH LOUISIANA CRUDE	C 9527	31	53	19	21
SOUTH LOUISIANA CRUDE	CRX-8	36	55	33	19
SOUTH LOUISIANA CRUDE	EVER 700	48	31	75	37
SOUTH LOUISIANA CRUDE	DASIC	42	27	50	50
SOUTH LOUISIANA CRUDE	BQ	62	71	80	35
SYNTHETIC CRUDE	C 9527	63	77	88	25
SYNTHETIC CRUDE	CRX-8	41	49	41	34
SYNTHETIC CRUDE	ENER 700	61	69	69	45
SYNTHETIC CRUDE	DASIC	25	23	30	21
SYNTHETIC CRUDE	BQ	55	89	42	34
TERRA NOVA CRUDE	C 9527	16	29	13	6.5
TERRA NOVA CRUDE	CRX-8	11	22	5.2	6.5
TERRA NOVA CRUDE	ENER 700	28	21	38	24
TERRA NOVA CRUDE	DASIC	40	19	58	44
TERRA NOVA CRUDE	BQ	40	40	53	27
TRANSMOUNTAIN BLEND	C 9527	8	14	6	3.1
TRANSMOUNTAIN BLEND	CRX-8	8	13	5.3	6.6
TRANSMOUNTAIN BLEND	ENER 700	28	17	43	25
TRANSMOUNTAIN BLEND	BQ	19	25	18	15
USED MOTOR OIL	C 9527	33	42	31	27
USED MOTOR OIL	CRX-8	31	39	31	23
USED MOTOR OIL	ENER 700	36	47	32	30
USED MOTOR OIL	DASIC	29	29	27	31
USED MOTOR OIL	BQ	36	42	41	24

EXPLANATION OF TESTS:

PREMIXED - REFLECTS THE LARGEST AMOUNT DISPERSED WHEN DISPERSANT MIXED INTO OIL AT RATIO 1:2

1-DROP - REFLECTS LARGEST AMOUNT DISPERSED AT A DISPERSANT TO OIL RATIO OF 1:10.
- TEST MEASURES HOW OIL/DISPERSANT COMBINATION FUNCTIONS WITH REAL APPLICATION.

2-DROP - REFLECTS LARGEST AMOUNT DISPERSED AT A DISPERSANT TO OIL RATIO OF 1:10 BUT DELIVERE IN TWO DROPS.
- TEST MEASURES THE HERDING EFFECT OF THE OIL/DISPERSANT COMBINATION WHEN COMPARED TO THE 1-DROP TEST.

BQ AND II ARE EXPERIMENTAL DESPERSANTS MADE BY EETD

TL - TO LOW TO MEASURE

When oil to water ratios of 1 to 1,000 and settling times of 10 minutes were used with traditional laboratory effectiveness protocols (including the Labofina, Mackay, and the Swirling Flask), techniques showed reproducible results for most of the oils listed in Table 1.

Additional research on emulsion inhibitors and visco-elastic agents have been conducted by MMS and EC (Gershey and Batstone, 1988) both in the laboratory and at sea. Both treating agents were successful. The demulsifier significantly inhibited the formation of emulsions or broke up emulsions while the oil was on the ocean surface. Demulsifier was used at concentrations ranging from 250 to 4,000 ppm. The visco-elastic agent also performed well in the laboratory and at sea. Laboratory and tank tests indicated that under certain conditions skimmer recovery rates could be increased by an order of magnitude. At sea, emulsion formation was inhibited and the adhesive character of the oil increased by concentrations of 1,000 to 10,000 ppm. Both treating agents modified the characteristics of the oil to significantly enhance its recoverability and burnability in-situ.

The MMS, EC and API is continuing research to identify and evaluate other chemical treating agents.

In-Situ Burning

The major advance in spill response has resulted from joint research begun in 1983 to determine the limiting conditions for burning oil on the surface of the open ocean. This effort was conducted at the (OHMSETT) facility in Leonardo, New Jersey. Prudhoe Bay, Amuligak, and several other crude oils were evaluated to determine the effects of selected physical variables including slick thickness, weathering, sea state, wind velocities, air and water temperatures, degrees of emulsification, and degrees of ice coverage (Smith and Diaz, 1985). All of the oils tested burned with 50 to 95 percent removal ratios, as long as emulsification had not occurred. Effects of ice coverage from less than 30 and up to 98 percent, wind speeds from calm to 50 knots, and water temperatures from -1° to $13^{\circ}C$ were minimal to the outcome. Weathered, but not emulsified, oils burned with a higher percentage of removal than did the fresh oils. This was unexpected but appears to be a function of increased viscosity as weathering occurs.

Based upon the success of this research, MMS began to explore how major burns affect air quality. A joint research effort with EC began in 1985 to quantify burn products and to model the behavior of the products as a function of time and cooling. This research was conducted, under contract, by the National Institute of Standards and Technology. The modeling uses a Department of Defense "Nuclear Winter" computer model, which addresses the behavior of the smoke plumes from numerous fires in a defined area (Evans, 1988). Continuing analyses of airborne pollutants indicate that dioxins, furans, and polynuclear aromatic hydrocarbons (PAH) are not generated as a result of combustion. PAH compounds in the oil are partially destroyed or converted to higher molecular weight compounds which are less acutely toxic (Evans et al., 1989). The next phase of this research is to evaluate the scaling effects on efficiency, pollutant loading, and airborne plume behavior. This is scheduled for the summer of 1990 with at-sea verification in 1991-92.

Results indicate that within certain constraints, in-situ burning should be considered as a primary response strategy especially in remote areas where logistics play a key role in limiting conventional response capabilities.

Oil Characterization

Oil properties, which significantly affect spill response, change rapidly after initial contact with the ocean surface. Physical properties (pour point, viscosity, density, water content, etc.) change rapidly as a result of evaporation, photooxidation, emulsification, sediment loading, evaporation, adhesion to debris, and others. The MMS joined with EC in 1986 to evaluate the effects of the most significant weathering phenomena. Of particular interest were the more exotic oils, such as the heavier oils produced offshore of California. Significant changes in physical properties of these and other oils have been reported (Bobra, 1989).

OHMSETT

The MMS with cooperative support from the USCG and EC have initiated a major effort to refurbish facilities and reinitiate research at the OHMSETT facility. This open-air test tank has the capability of testing oil recovery equipment in oil and in repeatable wave conditions while towing. Approximately 95 percent of the performance data on recovery equipment was generated at OHMSETT. The facility will be used to evaluate and develop new and innovative oil-spill response strategies.

Shoreline Cleanup

The MMS began in 1986 with EC to develop a matrix analysis program to evaluate various beachline cleanup techniques. Both the effectiveness for cleaning various shoreline types and the effects of the cleanup techniques on the survival of biota and natural restoration of the shoreline community were studied. A matrix analysis has been developed and priorities have been assigned to shoreline types. The cooperatives are continuing attempts to obtain the necessary permitting. Field research is expected to be initiated in 1992 to address the issue of the level of ocean cleanliness and what effect the level of cleanliness will have on natural restoration of the beaches.

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COOPERATION IN COUNTER-POLLUTION RESPONSE: THE EUROPEAN APPROACH

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Abstract

Counter-pollution arrangements in Europe are the object of an effective, dynamic, and highly organized international cooperation. The North Sea area, in particular, is characterized by an impressive concentration of oil-combating equipment and by a high level of know-how. Though national policies with respect to spill management may still differ on many counts, governments are striving towards a harmonized approach of spill combating. Technically, the ability to prevent environmental damage in case of a large oil spill remains limited, but the European approach could be regarded as a valid attempt to mitigate damage, prevent chaos and limit the waste of valuable resources.

Introduction

The European approach to oil-spill management and, more generally, to counter-pollution response at sea has been profoundly influenced by two major accidents: the Torrey Canyon in 1967 and the Amoco Cadiz in 1977. The first of these accidents led to the adoption of several important conventions in the framework of the International Maritime Organization (IMO). The second accident caused unprecedented public emotion and marked the beginning of a more concrete, practical co-operation of all North Sea states. It also sparked an initiative of the European Economic Community (EEC) that materialized in an action program that has grown more ambitious ever since. International cooperation in northern Europe can now be described as effective, dynamic, and highly organized. The North Sea area, in particular, is characterized by an impressive concentration of sophisticated counter-pollution equipment, held both in the private and the public sectors, and by a high level of know-how. As one more oil disaster, the Exxon Valdez accident, is now prompting governments to adopt more global arrangements for mutual assistance in the case of

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